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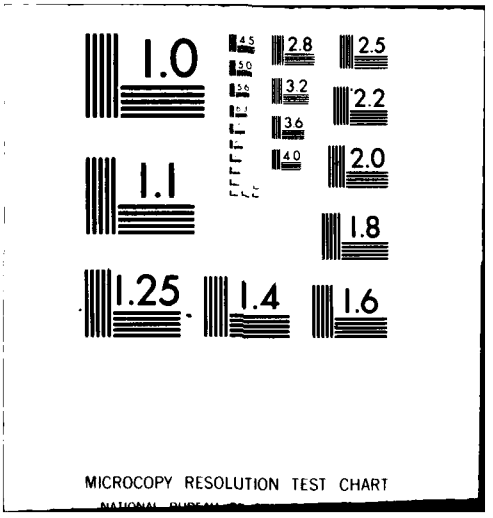
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EOARD REPORT

EUROPEAN FIBER OPTICS

USAF LABORATORY EXPERTS' VISIT

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European Office of Aerospace Research and Development

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20. Abstract A team of USAF laboratory experts conducted an assessment of European expertise in fiber optics research, development, and products. Organizations in England, France, Germany and the Netherlands were visited. The team's conclusion is that, while the US holds the advantage in many areas (especially in the development of new components), Europe leads in system implementation and has several unique components and processes of value to the US fiber optics effort. A brief review of each visit is included.		

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This report has been reviewed by the Information Office (EOARD/CMI) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be releasable to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

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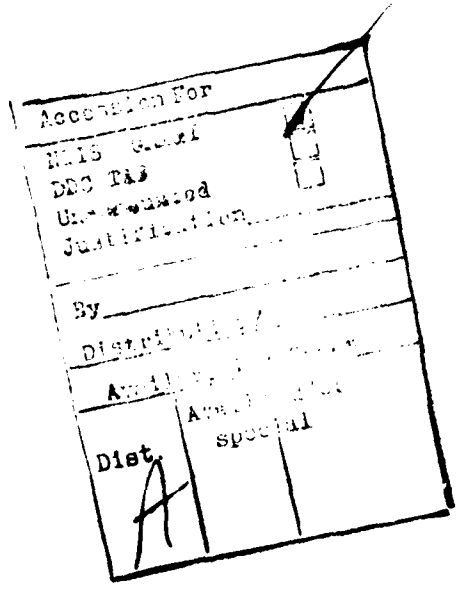

EUROPEAN FIBER OPTICS - USAF LABORATORY EXPERTS' VISIT

During the first half of 1978, at the request of the Air Force Avionics Laboratory and the Rome Air Development Center, Major J. Correll of the European Office of Aerospace Research and Development (EOARD) conducted a survey of the European involvement in fiber optics. Over twenty organizations were visited, including universities, government establishments, and commercial firms. Based upon this preliminary investigation, EOARD recommended a set of in-depth visits by fiber optics experts from the USAF laboratories. These visits were to be made to organizations which appeared to be leading in research or development of fiber optics technology.

This laboratory experts' visit has now been accomplished. For two weeks in March/April 1979, USAF scientists visited organizations in England, France, Germany, and the Netherlands. Three laboratories were directly represented:

Air Force Avionics Laboratory - Mr. E. Mason Friar
Air Force Weapons Laboratory - Mr. Edward W. Taylor
Rome Air Development Center/
Deputy for Electronics Technology - Dr. Andrew Yang

In addition, two EOARD officers accompanied the three experts to represent indirectly the interests of the other laboratories and to help establish the ground work for further programs:

Captain Armen E. Mardiguian, Physics Liaison Officer
Captain Randall L. Ray, Electronics Liaison Officer

The five members of the group visited a total of thirteen organizations, sometimes as a group but more often split into two teams.

In addition, two members of the group (Mr. Friar and Captain Ray) attended the Electronic Components '79 exhibition. The following summary contains general information about each organization and a short description of items of interest. The organizations are listed in chronological order of the visits.

Post Office Research Centre (PORC)
Martlesham Heath
Ipswich IP5 7RE, England

Principal Contact: Dr. J. E. Midwinter, Head, Optical Communications Group

The Post Office Research Centre has an extensive program in fiber optics, concentrating on telecommunications applications. The Centre performs a small amount of component work, though most of it is done in cooperation with British electronics companies. The Centre's strong emphasis is on systems. Researchers are working on a high performance system using injection laser diodes (ILDs) and single mode fibers for 565 Mbits/s transmission. Repeater spacing would be 50 km or more. PORC presently makes its own fiber by the double crucible technique. Other research involves novel techniques for coupling light into and out of fibers.

The Plessey Company Ltd.
Allen Clark Research Centre
Caswell, Towcester
Northants. NN12 8EQ, England

Principal Contact: Mr. G. Gibbons - Manager, Optoelectronic and Microwave Research

Plessey's research emphasis is on components. They are developing a large variety of sources (principally light-emitting diodes (LEDs))

and detectors. They are moving toward longer wavelengths with quaternary materials, and claim to have the most efficient 1.3 micron LED yet produced - 100 μW coupled into a .16 NA fiber using a 25 mA drive current. Plessey is working under an Avionics Laboratory contract to develop a hermetically-sealed, pigtailed LED.

Centre National d'Etudes des Télécommunications (CNET)
22301 Lannion, France

Principal Contact: Dr. H. A. Combet

CNET has an extensive fiber optics program ranging from fairly basic research to systems. Since it is the French equivalent of the PORC, it is not surprising that CNET's work is almost exclusively devoted to telecommunications. Many of the components used by CNET are developed by Thomson CSF, including an LTT (Lignes Télégraphiques et Téléphoniques) cable which holds fibers in a plastic V-grooved cylinder. An operational telephone system, now under test in Lannion, will be installed in Paris in 1980. It will include 70 fibers operating at 34 Mbits/s over a 7-8 km link.

Quartz et Silice
Avenue du 11 Novembre
45300 Pithiviers, France

Principal Contact: Mr. D. Boucher - Marketing Manager

Many of the preforms for optical fiber manufacturers are produced by Quartz et Silice, using their plasma deposition process. They also market their own line of fibers, which were used by some of the other organizations we visited. Their fluorine-doped preforms may produce fibers with less sensitivity to nuclear radiation. They also

have experience with many types of coatings for plastic clad silica (PCS) fibers, and are working with the French Ministry of Defense (DRET) on coatings for low temperature (-75°C) applications. While at Quartz et Silice, we learned of a cooperative program by four French cable manufacturers - ATI Electronique, Radiall, Socapex, and Souriau - who have developed a compatible connector for their single PCS fiber cables.

Thomson CSF
Laboratoire Central de Recherches
Domain de Corbeville
B.P. 10
91401 Orsay, France

Principal Contact: Mr. B. Desormiere - Manager, Optical Communications Group

Both component and systems work is being done by Thomson CSF. They have developed the "EROS" transmitter/receiver module that uses a common diode as both the LED and detector. Fiber is being produced by the CVD process and by a Phasil method similar to the Catholic University process. Other developments at Thomson CSF include a silicon heat sink for laser diodes (which features an etched-in V-groove for pigtail positioning) and plans for a laser diode with a 0.1 micron thick active region.

Laboratoires de Marcoussis
Centre de Recherches de la Compagnie Générale d'Electricité (CGE)
Route de Nozay
91460 Marcoussis, France

Principal Contact: Mr. J. Ernest - Assistant to the Scientific Director

The research center of the Compagnie Generale d'Electricite is

working on fibers and optoelectronic components. They are currently working with GaAlAs emitters and Si detectors, but there are plans to work at 1.3 microns using GaInAsP/InP emitters and, initially, Ge detectors. Detectors using III-V compounds will be introduced later. Fibers are produced by the double crucible and modified CVD (MCVD) techniques; the goal is a single mode fiber with 4-5 dB/km attenuation at 850 nm.

Direction des Recherches, Etudes et Techniques
26 Boulevard Victor
45015 Paris, France

Principal Contact: Professor Lamont - Scientific Advisor

This scientific/engineering arm of the Ministry of Defense coordinates much of the French fiber optics work. DRET sponsors systems work and testing of components, and is the point of contact for any foreign visitors wishing to talk with the French companies. As it is the focal point for data exchange agreements (DEAs), DRET suggested the possibility of a DEA on fiber optics (primarily component-oriented). Other projects of note are a development program for field-deployable connectors, and a fiber testing program which covers effects of temperature, nuclear radiation, chemicals and mechanical forces.

Siemens AG
Central Research Laboratories
Otto-Hahn-Ring 6
8000 Munich, Germany

Principal Contact: Prof. Dr. W. Heywang - Vice President, Laboratory Director

Siemens is a large electronics company and the research facilities

are new and well supported. The fiber optics work is very solid in components and systems. Their main research thrusts are in the areas of GeO_2-doped fibers (where they hope to achieve losses of 1 dB/km at 1.3 micron), polymer-clad fused silica (with losses of 3 dB/km), and SiC LEDs emitting at 480 nm.

AEG-Telefunken
Telecommunications and Cable Systems Division
Postfach 1120
7150 Backnang, Germany

Principal Contact: Dr. K. D. Schenkel - Head of Communications Research Group

AEG-Telefunken has strong programs in both components and systems. They have developed systems for the German Ministry of Defense and Post Office and for an electric utility company. They have produced monomode InGaAsP ILDs and monomode fiber with losses of less than 1 dB/km at 1.1 μ wavelengths. Other components include a 3 GHz reach-through avalanche photodiode and a PIN diode which can tap off a small fraction of a signal and transmit the remainder.

Heraeus Quarzschmelze GmbH
Postfach 463
6450 Hanau 1, Germany

Principal Contact: Dr. K. H. Rau - Leader for Research and Development

Heraeus is the world leader in the silica tube market (for the MCVD process). Japan is their best customer; their US sales are through Amersil. Two of the tube materials are Suprasil (>1000 ppm OH^- content) and Suprasil-W (<5 ppm OH^- content); they also make Fluosil preforms (fluorine-doped) that preliminary tests indicate

may have superior nuclear radiation resistance. Heraeus is currently working on a graded index preform technique which they expect will yield fibers with 1-2 nm/km dispersion. The process also allows for a wide range of core/cladding ratios.

N.V. Philips Gloeilampenfabrieken
Eindhoven, The Netherlands

Principal Contacts: Mr. J. van Zanten - Department for Military Affairs
Mr. M. P. Smid - NKF Cable Division

Philips Research Laboratories have a very extensive program in fiber optics. Philips is heavily involved in systems development, which often pushes the component work (e.g., ILDs for video discs). The Laboratories are working on a hermetically sealed laser with a ball lens mounted inside the package to increase coupling to a pig-tail mounted outside the hermetic package. Fibers are produced by the standard double crucible technique and by a unique plasma CVD method. Other efforts include development of a planar Si APD, and a DC arc fiber splicer that uses a shadow-graph for alignment purposes.

Standard Telecommunication Laboratories, Inc. (STL)
London Road
Harlow, Essex CM17 9NA, England

Principal Contact: Dr. M. Chown - Manager, Optical Systems Research Department

As the local version of ITT, STL has much in common with the fiber optics work at Roanoke and other US locations. However, they have their own efforts on systems and components. Their forte is laser diodes, where they are currently working toward 1.6 micron

wavelengths. They now have single mode 1.3 micron ILDs with a 6 mW output at 210 mA drive current. They are also interested in nuclear radiation effects on components, and are performing extensive tests under Ministry of Defence sponsorship at the Royal Signals and Radar Establishment (RSRE) at Malvern.

Royal Aircraft Establishment (RAE)
Farnborough, Hants. GU14 9NA, England

Principal Contact: Dr. R. Tyte - Manager, Electro-Optics

RAE is the British Ministry of Defence establishment responsible for fiber optics as they may be applied in avionics systems. They support efforts in both components and systems, but have no in-house work except some testing. RAE has a sincere desire to couple British and US efforts in fiber optics. The Plessey work on emitters is one example of this cooperation. RAE is also heavily involved in NATO standardization efforts in fiber optics. They are supporting work on single fiber/tight sheath and fiber bundle cables, with full temperature specifications and high tensile strength requirements. The RSRE radiation tests are coordinated by RAE.

Conclusions:

In general, it appears that the US has a slight lead in the fiber optics components area, while Europe leads in system implementation. Lincoln Laboratories and other groups in the US have a significant advantage in research on long wavelength emitters, especially laser diodes. At the European organizations visited, little effort was seen on InP substrates for these types of components. The US is

also leading in development of the alkyl process for III-V materials growth.

Having said that the US is generally leading Europe in the fiber optics components area, we must point out several important exceptions. A point to consider is that the European companies are very concerned about the market for fiber optics. They have thus oriented many of their efforts toward what they perceive is their most likely market - the low cost, low performance system. As a reflection of this, the Europeans have developed several products which are equal to the US in most respects: GaAs and GaAlAs LEDs and ILDs; double crucible fibers; and receivers and transmitters for relatively short (<10 km), low bandwidth systems.

Some higher performance components are also equal to or better than their US counterparts, and there are some things uniquely available in Europe at this time. These include pigtailed hermetically sealed emitters, specially-doped fibers and preforms, and new processes for preparing preforms.

In all four of the countries we visited, there was a large amount of systems development. There are a multitude of demonstration links in operation, and a growing number of actual systems in use. The majority of these are communications-related. However, there is a significant effort on military systems as well, most notably in the UK and France where RAE and DRET are supporting work at several companies. RAE is involved in a bilateral standardization effort with the US. While it is unlikely that the Air Force can directly make

use of any of these systems, it is reasonably certain that the underlying technology, including system architecture and components, should be valuable.

Nuclear radiation effects testing was also discussed, and several European organizations are involved in this area. However, the actual extent and approach of these tests was not determined. This was due, to a large extent, to a reluctance by the companies to discuss tests that were sponsored and performed by government organizations. The results may be made available through direct contact with organizations such as DRET and RAE.

In summary, while the USAF should not expect to solve all its problems by using European fiber optics technology, it can certainly gain by cooperative efforts in several significant areas.

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